Relationship Of The Shelfbreak Jet To The Adjacent Slopewater Circulation In The Middle Atlantic Bight

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LONG-TERM GOALS

The long-term goal is to understand the variability, forcing and dynamics of the shelfbreak current and how this impacts the propagation of sound across the shelfbreak. Of particular interest is how the offshore slopewater circulation impacts the shelfbreak current.

OBJECTIVES

The main objectives of this study are (1) to elucidate the nature and cause of the fluctuations of the shelfbreak current, including the role of the bottom boundary layer, and (2) to determine the mean and fluctuating currents/water-masses on the adjacent continental slope, with emphasis on the coupled nature of the slopewater circulation and shelfbreak current.

APPROACH

This study is part of the Shelfbreak PRIMER experiment addressing the acoustics and physical oceanography of the shelfbreak front and adjacent slopewater in the Middle-Atlantic Bight. The fieldwork consisted of long-term moored observations both at the shelfbreak (two upward-looking ADCPs) and on the continental slope (three tall VACM moorings), supplemented by repeat shipboard velocity measurements and hydrography. All measurements were carried out along TOPEX altimetric track C126 (near 70°W) over a two year period from December 1995 to December 1997.

WORK COMPLETED

We are now in the final analysis stage of this project. To date there have been three papers published and one accepted. These have primarily used the hydrography and shipboard ADCP data to study the structure and dynamics of the shelfbreak jet. Presently we are investigating the time variability of both the shelfbreak jet and the adjacent slopewater circulation using the PRIMER moored data (see II below).

RESULTS

(I) Dynamics of the Shelfbreak Jet

In last year's report we presented our efforts describing the mean velocity structure of the jet using a collection of repeat shipboard ADCP crossings. Since then, we have investigated the dynamics of the

mean jet using these same data, including the nature of the secondary circulation. The alongstream flow of the jet, which extends to the bottom, is primarily in geostrophic balance. In the cross-stream plane the jet is strongly convergent, which we assume is primarily due to the convergent local topography. We have shown that this confluent flow drives an ageostrophic downwelling cell, similar to the secondary cell described by Pollard and Regier (1992), only in this case driven by the topography. The cell is asymmetric, with convergence/downwelling at and offshore of the jet core, and weaker divergence/upwelling on the inshore side of the jet.

(II) Variability of the Shelfbreak/Slope Currents

We are also investigating the time variability of the shelfbreak and slope currents using the moored data from the PRIMER experiment. The two upward-facing bottom-mounted ADCPs reveal intriguing quasi-regular eastward flow reversals of the jet (Figure 1). We are presently investigating the nature of these reversals, and are focusing on three different possibilities: (1) wind-driving, (2) instabilities of the jet, and (3) slopewater forcing. At this point we have not definitively identified the cause, but we are concurrently analyzing nearby wind-buoy records, regional AVHRR, as well as the adjacent PRIMER slopewater moored time series, which will help elucidate this unexpected mode of shelfbreak jet variability.

IMPACT / APPLICATIONS

The role of alongstream variation in topography on the shelfbreak jet has not received much attention from the theoretical and modeling side. Our results, both last year and this year, suggest that local variation in topography can alter the dynamics of the jet via the secondary circulation — in the upper layer and at depth. This in turn impacts the distribution and vertical transport of properties at the shelfbreak, which likely affects both the biology and acoustics.

TRANSITIONS

None.

RELATED PROJECTS

The shelfbreak PRIMER is a collaborative experiment between acousticians and physical oceanographers, and there has been extensive interaction between both groups. The coastal mixing and optics experiment also took place during the time period of PRIMER, focusing on the shelf. Collaborative work has been initiated with S. Lentz to address recently revealed coupled variability between the shelfbreak and shelf.

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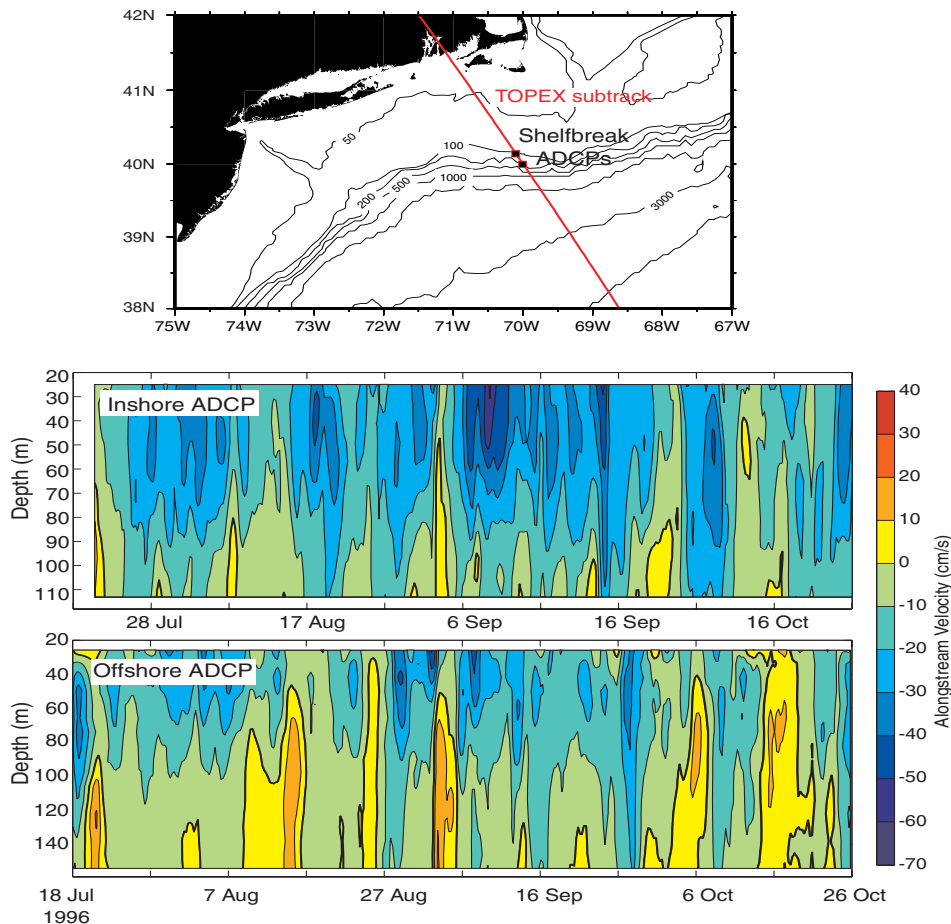
Figure 1. Timeseries of alongstream velocity as measured by the two shelfbreak PRIMER ADCPS. The timeseries shown is a subset of the full 14-month record and has been low-pass filtered and subsampled at six-hour intervals. The alongstream direction is defined by the average orientation of the variance ellipses calculated at both ADCP sites. The zero contour is denoted by the heavy contour line so that the orange and yellow shading correspond to poleward flow.